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# MASTERY TRAINING: EFFECT ON SKILL RETENTION

Stephen L. Goldberg, Michael Drillings,  
and J. Douglas Dresel

TRAINING TECHNICAL AREA



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Research Institute for the Behavioral and Social Sciences

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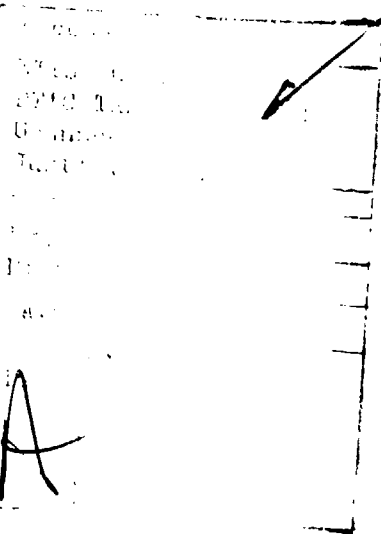
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five weeks after training. Each step of the task performance was scored "GO" or "NO GO." When a crewman performed a step incorrectly, the scorer would correct the step before permitting the crewman to continue.

The results indicate a significant effect of both amount of training and length of retention interval on recall of the task, but no interaction between the variables. Crewmen perform better on the retention test after the shorter retention interval or after more intensive training. Differences in performance among the groups are mostly caused by differences on the first retention trial. There is no correlation between ability to perform or retain the task and mental category. The reason for this result may be the lack of variance among crewmen's mental categories. ←

Although the mastery training provided aided retention of the task, only 15% of the mastery trained crewmen were able to perform the task correctly on the first retention trial. The results indicate that mastery training is not efficient for all tasks. Mastery training as compared to refresher training, however, may be useful for tasks that have few steps, must be recalled from memory, must be performed correctly on the first attempt, or for which there are inadequate resources for refresher training.



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# **MASTERY TRAINING: EFFECT ON SKILL RETENTION**

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**Combat Skill Development  
and Retention**


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## FOREWORD

The mission of the Training Technical Area of the Army Research Institute for the Behavioral and Social Sciences (ARI) is to provide research support to Army training programs. A major focus of this research is to develop fundamental data and technology necessary to field integrated training systems for improving individual job performance. Such systems include Skill Qualification Testing (SQT), job performance aids, training courses in schools and in the field, performance criteria, and management and feedback systems. This report is one of a series on the task and training factors that affect soldier's ability to retain job skills. The long term goal of the research is to develop criteria for establishing the most appropriate strategies for initially training and retraining all types of Army skills. The work is in response to requirements of the Deputy Chief of Staff for Training of the Army Training and Doctrine Command (TRADOC). The work was accomplished by ARI personnel under Army Project 2Q263743A794, FY 1980, "Combat Skill Development and Retention" for the Deputy Chief of Staff for Training, TRADOC, with the support of the US Army Armor School, 7th Army Training Center, and the 8th Infantry Division.

  
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Technical Director

## MASTERY TRAINING: EFFECT ON SKILL RETENTION

### BRIEF

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#### Requirement:

Determine the effects of mastery training and length of retention interval on retention of a procedural skill.

#### Procedure:

Armor crewmen were individually trained to boresight and zero the main gun of the M60A1 tank. Crewmen were trained to either of two criteria: one correct performance (standard training) or three consecutive correct performances (mastery training). Crewmen's retention of the task was tested either one or five weeks after training. Each step of the task performance was scored "GO" or "NO GO." When a crewman performed a step incorrectly, the scorer would correct the step before permitting the crewman to continue.

#### Findings:

The results indicate a significant effect of both amount of training and length of retention interval on recall of the task, but no interaction between the variables. Crewmen perform better on the retention test after the shorter retention interval or after more intensive training. Differences in performance among the groups are mostly caused by differences on the first retention trial. There is no correlation between ability to perform or retain the task and mental category. The reason for this result may be the lack of variance among crewmen's mental categories.

#### Utilization of Findings:

Although mastery training aids retention of this task, still, only 15 percent of the mastery trained crewmen are able to perform the task correctly on the first retention trial. The results suggest that mastery training may not be the most efficient strategy for all tasks. Mastery training as compared to refresher training, however, may be useful for tasks that have few steps, must be recalled from memory, must be performed correctly on the first attempt, for which there are inadequate resources for refresher training, or for which job aiding is not feasible.



# MASTERY TRAINING: EFFECT ON SKILL RETENTION

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## INTRODUCTION

Army readiness is partly dependent upon the ability of individual soldiers to adequately perform the critical tasks that make up their Military Occupational Specialty (MOS). The individual training mission of the Army is to impart necessary job skills to soldiers and then insure that these skills are maintained over the individual's service time. Carrying out this mission is difficult because Army jobs are composed of thousands of tasks that vary widely in the demands they place on soldiers and resources.

Soldiers currently receive initial job training in a US Army Training and Doctrine Command (TRADOC) school or training center. They arrive at an Active Army or Reserve Component unit having had training in a prescribed subset of tasks. Once in their units soldiers are supposed to receive refresher training on tasks they have learned earlier and on-the-job training on tasks not taught in institutions (Training Circular TC 21-5-7). Problems arise in this system because the training institutions must distribute limited time and resources to train large numbers of tasks that vary in how difficult they are to learn, master, and retain. Refresher training in the unit is difficult because training managers lack sufficient information about when to most effectively schedule training. Also there are conflicting demands on available time and training resources.

The Army Research Institute for the Behavioral and Social Sciences (ARI) has been carrying out a research program to determine factors that affect the learning and retention of Army tasks. The overall objective of the program is to provide training managers with optimum strategies for training and maintaining all types of tasks.

ARI has completed a review of the skill retention literature (Schendel, Shields and Katz, 1978) and several retention research projects in Basic Training Skills (Shields, Goldberg, and Dressel, 1979), Typewriting (Hagman, 1979), Chapparral Missile Skills (Shields, Joyce, and Van Wert, 1979) and Armor Skills (Osborn, Campbell, and Harris, 1979). The research results indicate that the rate of loss of task proficiency varies widely among tasks. It seems to be a function of the nature of the task, the degree of original learning or the way the task was trained, intervening skill practice, and the extent of job aiding employed.

Since both the nature of the task and training methods affect later performance, it is reasonable to assume that use of certain training methods could enhance skill retention for certain classes of tasks. Mastery training is a training method designed to increase the soldier's level of original learning. Trainers frequently assume that soldiers have learned a task after they have performed it once successfully. In mastery training the trainee continues to perform the task to some predetermined point past the first successful performance. The continued practice has been shown to enhance retention performance for a number of

laboratory tasks, both verbal and motor (Kreuger, 1929; Postman, 1962; Melnick, 1971). The application of mastery training in initial training may be a useful alternative to frequent refresher training if it can be shown that the increased time needed for mastery training results in superior retention performance and is cost effective. Mastery training would be particularly important for combat tasks, such as gunnery skills, which require use of expensive or scarce resources for their training.

In a prior ARI research project which examined retention of common soldiering skills, Shields et al. (1979) found that task performance decay rate was related to the number of steps in the task and whether the task contained subtasks. Tasks that had many steps and one or more subtasks had rapid rates of performance decay. In the present research we chose to test the impact of mastery training on retention of a very difficult task to set an upper bound on the potential benefits of mastery training. The task used was "boresight and zero the main gun of the M60A1 tank." The task contains 27 performance steps within two subtasks.

### OBJECTIVE

Mastery training has been shown to enhance retention in laboratory experiments using verbal and motor tasks. The applicability of this training technique in military settings will depend on the cost effectiveness of mastery training versus refresher training. The objective of this research was to evaluate the effect of mastery training on retention and relearning for a difficult military task "boresight and zero the main gun of the M60A1 tank."

### METHOD

#### Research Participants

Forty-two soldiers assigned to an armored battalion in West Germany participated in the research. All of the soldiers were armor crewmen. Five soldiers were tank commanders, 19 were tank gunners, 14 were loaders and 4 were drivers. Tables 1 and 2 present the soldiers' grades and time in the Army.

#### Research Design

The research design was a 2x2 factorial design. There were two levels of initial training: criteria of one correct and three correct successive task performances. The three successive correct performance condition was considered the mastery condition. There were two retention intervals: one week and five weeks. Soldiers were randomly assigned to training conditions and retention intervals with the exception of those in one company who were forced to be in the one week group because of other training commitments.

#### Task

Research participants performed two tasks: boresight the M60A1 tank and zero the M60A1 tank main gun. For purposes of the research the tasks were treated as one complex task with two components. The total

TABLE 1

## Grade of Participants

Grade	Number	Percent
E1	2	4.8
E2	1	2.4
E3	10	23.8
E4	13	31.0
E5	<u>16</u> 42	38.0

TABLE 2

## Time in Service of Participants

Time	Number	Percent
Less than 1 year	3	7.1
Less than 2 years	5	11.9
Less than 3 years	15	35.7
Between 3-5 years	16	38.1
More than 5 years	<u>3</u> 42	7.1

complex task required soldiers to perform 27 discrete steps or performance measures. The boresight subtask consisted of 11 steps. The zero subtask consisted of 16 steps. Boresighting is the procedure whereby the main gun of the tank is aligned with its periscope and telescope sights. Zeroing corrects for any systematic error in firing a boresighted main gun. Appendix A contains the score sheet used to test soldiers. The score sheet lists an abbreviated description of the task performance measures. Hughes (1977) describes the boresighting and zeroing procedures in detail.

### Procedure

The research participants first filled out a short questionnaire which gathered demographic data and information on their experience in performing the boresighting and zeroing tasks (Appendix B). Each questionnaire had a number stamped on it. This number was used to randomly assign soldiers to the two training groups. Soldiers in the mastery training group were required to perform the task correctly three times in a row. The other group performed the task to a criterion of one successful performance. Technical manuals or job aids that might normally be used to perform this task were not allowed to be used in order to increase task performance difficulty for experimental purposes.

Two Army Research Institute researchers individually trained each soldier to perform the boresighting and zeroing task initially and then retested them following the appropriate retention interval. The researchers instructed each soldier to perform the duties that a tank gunner would perform in boresighting and zeroing. The researchers assisted by performing the duties of the tank commander and loader. The soldiers were told to perform the task and describe what they were doing. When possible, they used a boresight target positioned at 1200 meters to perform the task. Fog and rain occasionally made it necessary for the experimenters to substitute simulated targets at closer distances. The boresighting and zeroing procedure is such that it is unlikely that target substitution resulted in any systematic error.

As each soldier performed, the researcher scored each task performance measure "GO" or "NO GO". When a soldier made an error, the researcher corrected the performance and told the soldier to continue. At the conclusion of the boresight subtask the soldier was told that he completed boresighting and that he must now zero the main gun. For purposes of this research, the soldiers only simulated zeroing; no live rounds were fired. Each repetition of the task took from 5 to 40 minutes, with the average being ten minutes.

During acquisition training, soldiers continued to perform the entire boresight and zero task until they had correctly performed it the required number of times for their training group.

The procedure for retesting soldiers after a retention interval was the same as for the acquisition session, with the exception that all soldiers performed the task to a criterion of two successive correct performances.

Because of personnel turnover and other training requirements, 15 soldiers who had been initially trained could not be retested. No other soldiers were eliminated from the experiment. Table 3 shows the number of soldiers in each condition who completed the entire experiment.

TABLE 3

Number of Soldiers in Each Condition

Retention Period	Level of Training	
	Standard	Mastery
One Week	10	11
Five Weeks	12	9

RESULTS

The dependent measures used for the boresighting and zeroing task were the number of trials crewmen need to reach criteria, the total number of errors on all trials, and number of performance measures correct on the first three retention trials.

Acquisition

Assignments to experimental groups were random. One-way analyses of variance were performed on the number of errors soldiers made on the first two acquisition trials, total errors to criterion, and number of trials to criterion to test the possibility that some groups had a higher degree of prior skill on the boresighting and zeroing task. In each case there are no significant differences among the groups.

One of the reasons for choosing three successive correct performances as the criterion for the mastery training groups is to estimate the probability with which soldiers could be expected to perform tasks correctly on successive trials. Of the 20 soldiers who received mastery training only two made an error after performing the task correctly once. On the average for both the mastery and standard training groups soldiers perform 2.55 trials prior to their first correct performance.

### Skill Retention

Retention performance on the boresight and zero task varies both as a function of level of initial training and retention interval. Figure 1 shows the average total number of errors committed per soldier for the mastery and standard training groups for one and five week retention intervals. The main effects of training level,  $F(1,38)=4.38$ ,  $p < .05$ , and retention interval,  $F(1,38)=8.28$ ,  $p < .01$ , are significant. There is no interaction between training method and retention interval.

There is no significant difference in the number of trials it took for the mastery and standard training groups to reach criterion at either retention interval. The observed differences in performance between the groups is mostly the result of performance on the first retention trial. Figures 2 and 3 show the proportion of performance measures passed for the first two retention test trials. Performance on trial one (Figure 2) shows superior performance for mastery training at both retention intervals. The only significant difference which persists into the second retention trial is between the mastery training-one week retention group and the standard training-five week retention group, the two most divergent conditions. There are no differences in performance on the third trial. Treating trials as a repeated measure in an analysis of variance, (level of training x retention interval x trial) there is a significant interaction of trial x retention interval,  $F(1,38)=8.21$ ,  $p < .01$ , indicating that the decreased retention caused by the longer retention interval is negated by the learning that occurs on the first retention trial.

In general, soldiers' ability to perform the task successfully after both retention intervals was low. Using proportion of soldiers receiving "GO" for the entire task on the first retention trial as the dependent measure, the mastery training groups have a 15 percent "GO" rate and the standard training groups have 2.4 percent "GO" rate. This performance would clearly be unacceptable if task conditions required satisfactory performance on the first attempt. Under field conditions, however, it is unlikely that boresighting and zeroing would be performed unaided as was done in the research. Soldiers in the field are expected to use appropriate materials that remove much of the memory burden associated with performing the task.

### Subtask Analysis

"Boresighting and zeroing the main gun of the M60A1 tank" is a compound task that is made up of two tasks that could be performed independently. We were interested in whether the second subtask showed poorer performance than the first as found by Shields et. al. (1979), and if each task would show a different pattern of performance under mastery training conditions.



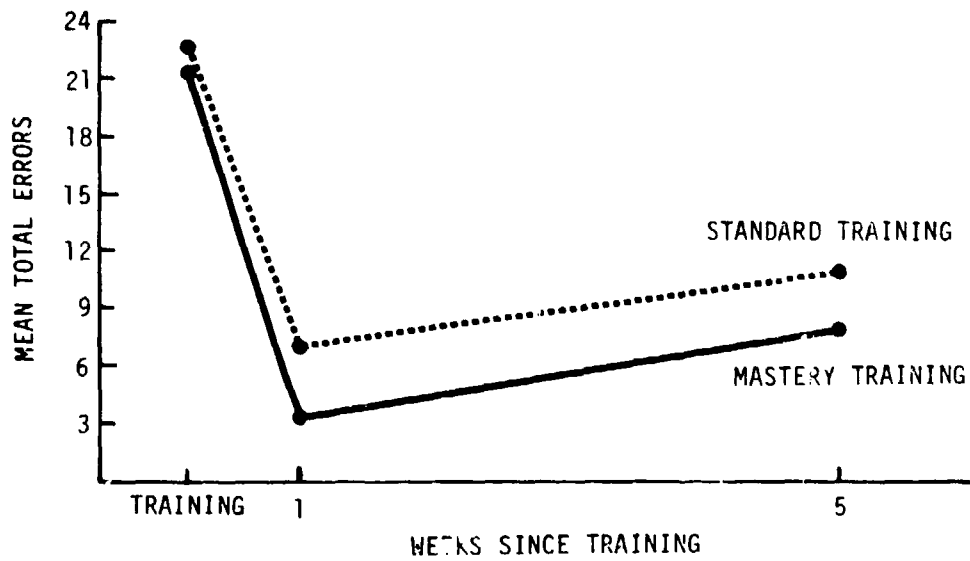


Figure 1. Total errors

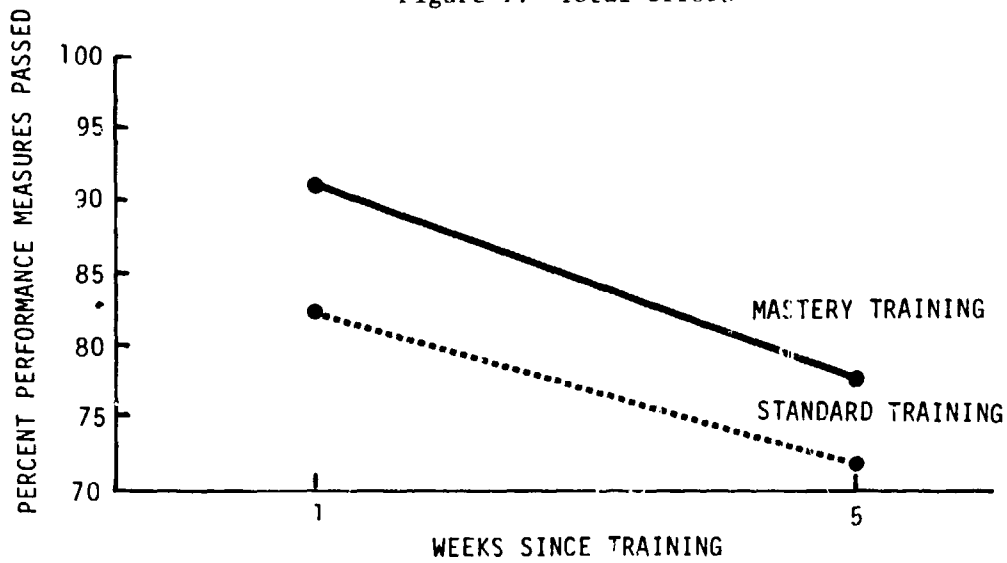


Figure 2. First retention trial performance

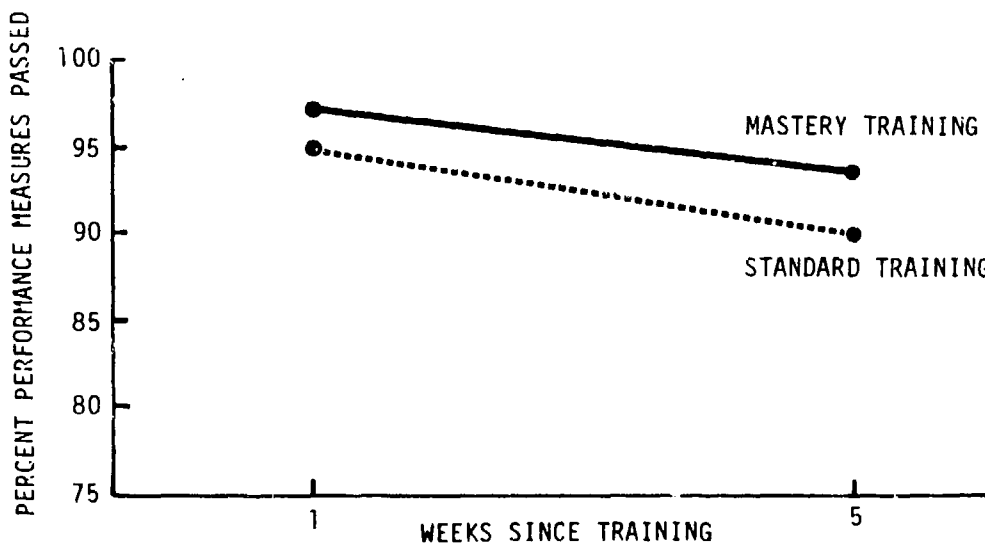


Figure 3. Second retention trial performance

The zeroing subtask is more difficult to perform correctly than boresighting during both acquisition and retention testing. A matched pairs t-test on the number of attempts for initial subtask success during retention testing indicates significantly ( $p < .01$ ) more zeroing subtask failures ( $\bar{x}=1.6$ ) than boresighting failures ( $\bar{x}=1.2$ ). The fewer errors on boresighting could be caused by the greater number of steps and therefore higher likelihood of failure in the zeroing subtask. Also, since soldiers needed 2.4 trials to acquire the zeroing subtask versus 2.0 for boresighting, they correctly practiced boresighting more times. This occurs because each time soldiers make an error on the more difficult zeroing subtask they had to repeat performance of both subtasks.

#### Retention results--Boresighting:

On the first retention trial there is a significant effect of length of the retention interval on the number of measures successfully completed,  $F(1,38)=4.51$ ,  $p < .05$ . There are no significant effects of retention interval on later retention trials. The effect of mastery training is not significant. The failure of mastery training to influence boresighting retention performance is probably caused by the confounding described above; because of the greater chance of error on zeroing, in effect, all soldiers received mastery training on the boresighting subtask.

#### Retention results--Zeroing:

On the first retention test trial there are significant effects of retention interval,  $F(1,38)=12.10$ ,  $p < .001$ , and mastery training,  $F(1,38)=3.96$ ,  $p < .05$ . The second trial still has a significant effect of retention interval,  $F(1,38)=4.55$ ,  $p < .05$ . By the third trial there are no differences in performance due to training or retention interval. Again the benefits of mastery training occur only on the first retention trial, and the effect is limited to increasing the number of task elements performed correctly. The "GO" rate for the subtask as a whole benefits minimally from the mastery training.

#### Performance Measure Errors

Shields, et al. (1979) found that soldiers tended to consistently make errors on the same task elements and that these errors tended to be on performance measures that were most memory dependent. They tended to be steps in the procedure that were either not highly related to the steps that preceded them or were not suggested by the hardware. Table 4 shows the errors made by soldiers on the first two trials of acquisition and retention testing. The items which soldiers failed most frequently in training also proved to be most troublesome in retention. Frequency of performance measure error was ranked for both acquisition and retention trials. Spearman rho coefficients (rho measures the degree of association between two ranked series) computed on error rates for task elements during acquisition and retention are 0.73 ( $p < .05$ ) for the boresighting subtask and 0.84 for zeroing ( $p < .01$ ) indicating that training affects the comparative number of errors on a given task element, but does not change the relative probability of making an error on one element as compared to another.

TABLE 4

## Distribution of Performance Measure Errors During Initial Two Task Attempts

Errors		Performance Steps
Training	Retention	
<b>BORESIGHTING</b>		
<u>16</u>	<u>2</u>	1. Index APDS (1-3 can be in any order)
<u>18</u>	<u>4</u>	2. Turns computer off
<u>14</u>	<u>6</u>	3. Turns superelevation to zero. (Check decimal indicator)
<u>21</u>	<u>11</u>	4. Tells Loader to align axis of main gun on upper left-hand corner of the bore-sight target. Gunner follows Loader instructions using manual controls.
<u>18</u>	<u>3</u>	5. Rotates M32 periscope elevation and deflection boresight knobs until aiming cross is on upper left-hand corner of target. (Check sight picture)
<u>35</u>	<u>16</u>	6. Rotates slip scales to read 4 and 4.
<u>20</u>	<u>5</u>	7. Unlock telescope elevation and deflection boresight levers.
<u>34</u>	<u>4</u>	8. Rotates knobs until boresight cross is on upper left-hand corner of target. (Check correct sight picture)
<u>10</u>	<u>0</u>	9. Locks levers.
<u>19</u>	<u>15</u>	10. Rotates slip scales to read 3 and 3.
<u>50</u>	<u>20</u>	11. Tells Loader to confirm lay of main gun.
<b>ZEROING</b>		
<u>24</u>	<u>11</u>	12. Turns on computer and presses reset button.
<u>37</u>	<u>12</u>	13. Tells Loader to load main gun.
<u>25</u>	<u>6</u>	14. Lays M32 periscope aiming cross on center of zero target using manual controls in "G" pattern. "Fire" (Check G pattern with range finder)
<u>28</u>	<u>6</u>	15. Tells Loader to load.
<u>16</u>	<u>4</u>	16. Relays aiming cross on center of target with manual controls in "G" pattern. "Fire"
<u>18</u>	<u>5</u>	17. Tells Loader to load.
<u>14</u>	<u>0</u>	18. Relays aiming cross on center of target with manual controls in "G" pattern. "Fire" (Tell Gunner shot group is in a corner of the target)
<u>47</u>	<u>20</u>	19. Tells Loader to load

Table 4--Continued

ZEROING		
<u>57</u>	<u>33</u>	20. Relays aiming cross on center of zero target using "G" pattern and manual controls. (Does not fire)
<u>36</u>	<u>11</u>	21. Rotates boresight knobs on M32 periscope until aiming cross is in the center of shot group.
<u>41</u>	<u>9</u>	22. Relays to center of zero target using manual controls in "G" pattern. "Fire" (Check with range-finder) "Zero confirmed"
<u>62</u>	<u>44</u>	23. Relays to upper left-hand corner of zero target using manual controls in "G" pattern. (Check with range-finder)
<u>34</u>	<u>5</u>	24. Unlocks telescope boresight levers.
<u>42</u>	<u>16</u>	25. Rotates boresight knobs until 1200 meter range line on appropriate reticle is centered on upper left-hand corner of zero target. (Check sight picture)
<u>27</u>	<u>1</u>	26. Locks levers.
<u>32</u>	<u>16</u>	27. Reads established zero for telescope and periscope.

Examination of the task elements where errors are likely again shows that these steps tend to be highly memory dependent with very few cues available from prior steps in the procedure or the hardware. For example, during retention testing soldiers err most frequently on the step in the zeroing subtask that involves relaying the main gun to the upper left hand corner of the zero target using the "G" pattern. Prior to this step the soldiers have been simulating firing the main gun. They must now remember to move the gun to a new aiming point using a "G" pattern that is somewhat different from the patterns used previously. The consistency with which errors are made on this type of task element indicates that special emphasis during training should be given to these items and that they should be stressed in refresher training. When resources are limited it may be most efficient for training to concentrate on memory dependent task steps.

#### Individual Differences

In addition to task and training factors, we analyzed the effect of ability level of the individual soldier on acquisition and retention performance. We were able to obtain mental category data from the Military Personnel Center for 32 of the 42 soldiers in the sample. Table 5 shows the distribution of soldiers by mental category. The mean AFQT score and GT score for the sample are 49 and 102 respectively. Correlating mental category, AFQT or GT score with either acquisition or retention performance results in no significant correlations. There is no consistent relationship between mental ability and retention performance either within or across experimental groups. The lack of an effect is probably due to 78 percent of the sample being in mental category III.

The homogeneous nature of the sample may hide differences that would result if there were a greater degree of variation in the measures of mental ability.

Experience did make a difference in acquisition performance. Gunners and loaders made up 80 percent of the sample. Most gunners have been in the Army longer, and hold higher grades than loaders. Gunners are also likely to have more experience with the boresighting and zeroing task. Given these factors it is not surprising that gunners learn to perform the boresighting and zeroing tasks in 1.7 fewer trials than loaders ( $p < .05$ ) and make 16.3 fewer errors ( $p < .001$ ) along the way.

TABLE 5

Mental Category of Participants

Category	Number	Percent
I	2	6.3
II	3	9.3
III	25	78.1
IV	<u>2</u>	6.3
	32	

DISCUSSION

In the present experiment, mastery training is operationally defined as three consecutive correct performances of the task. In training boresighting and zeroing, each task repetition takes about ten minutes. The mastery training groups, therefore, received approximately twenty more minutes of training time than the soldiers who were trained to a criterion of one correct performance. The extra training benefited subsequent performance. Soldiers in the mastery groups performed a higher percentage of task steps correctly than did the non-mastery trained soldiers. Is this improvement enough to justify the use of mastery training? The answer to this question depends on the costs of training and criticality of the task. For lengthy procedural tasks such as the task examined in this effort, mastery training does not appear to be a cost-effective strategy. Although mastery trained soldiers retained more than non-mastery trained soldiers, still, only 15% performed the task correctly on the first retention trial. This level of performance is not adequate for operational units. Moreover, for this task, the advantage of refresher training compared to mastery training is shown by the rapid relearning that occurs on the first retention trial.

Similar results have been obtained in other investigations. Both Ryan (1965) and Melnick (1971) found that mastery training or overlearning aided retention of a motor task. They both found, however, that short periods of retraining quickly brought the non-overlearning subjects up to the level of performance of the overlearning group. Hammerton (1963) found the same results for a difficult tracking task.

There are a number of possible reasons for the limited value of mastery training. In this effort and those cited above, overlearning or mastery training consisted of subjects performing a relatively small number of repetitions beyond their first successful performance. Fleishman and Parker (1962) had their subjects practice a 21 minute tracking task 17 times over a six week period. They found little decrement in performance after as long as 24 months of no practice and a high correlation between retention and level of original learning. Apparently, when mastery training is more extensive, the benefits are more pronounced. It is probably unrealistic to believe that the Army could afford that degree of practice for any but the most essential tasks.

Repetition alone may not be the best type of mastery training. Once a subject reaches some intermediate level of performance, mastery might occur faster and have a more lasting affect if in addition to repeating the task the subject also learned more about the task. Added knowledge might provide the necessary means for subjective organization that would aid retention and later recall performance.

Mastery training, compared to more standard Army training methods, did improve performance on the task studied, but the improvement would not be considered sufficient to justify the resources required for routine mastery training on the task. The results indicate that mastery training is probably inefficient for tasks that are complicated, that have no critical time constraint, and for which resources are available to support job aiding and refresher training. Mastery training may be appropriate for tasks that have few steps, must be recalled from memory, must be performed correctly on the first attempt, and for which there are inadequate resources for refresher training.

Future research in the area of mastery training should consider the factors that influence the decision to employ mastery training as the appropriate strategy for training particular tasks. Research also needs to address the methods of mastery training that result in the best performance. As stated earlier, repetition alone may not be the best or most efficient method for training to mastery.

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APPENDIX A  
DATA COLLECTION WORKSHEET

NAME \_\_\_\_\_ ID NUMBER \_\_\_\_\_ (1-3)  
 COMPANY PLATOON \_\_\_\_\_ (4-6) CONDITION \_\_\_\_\_ (7)  
 TRIAL \_\_\_\_\_ (8-9)

- | (1)<br>GO   | (2)<br>NO GO |  |
|---|--------------|--|
| (10) _____  | _____        | 1. Index APDS (1-3 can be in any order)  |
| (11) _____  | _____        | 2. Turns computer off  |
| (12) _____  | _____        | 3. Turns superelevation to zero. (Check decimal indicator)   |
| (13) _____  | _____        | 4. Tells loader to align axis of main gun on upper left-hand corner of the boresight target. Gunner follows Loader instructions using manual controls. |
| (14) _____  | _____        | 5. Rotates M32 periscope elevation and deflection boresight knobs until aiming cross is on upper left-hand corner of target. (Check sight picture)     |
| (15) _____  | _____        | 6. Rotates slip scales to read 4 and 4.  |
| (16) _____  | _____        | 7. Unlock telescope elevation and deflection boresight levers.   |
| (17) _____  | _____        | 8. Rotates knobs until boresight cross is on upper left-hand corner of target. (Check correct sight picture)   |
| (18) _____  | _____        | 9. Locks levers.   |
| (19) _____  | _____        | 10. Rotates slip scales to read 3 and 3.   |
| (20) _____  | _____        | 11. Tells Loader to confirm lay of main gun.   |
| YOU HAVE NOW BORESIGHTED THE MAIN GUN. NEXT YOU WILL ZERO IT. CONTINUE. |              |  |
| (21) _____  | _____        | 12. Turns on computer and presses reset button.  |
| (22) _____  | _____        | 13. Tells Loader to load main gun.   |
| (23) _____  | _____        | 14. Lays M32 periscope aiming cross on center of zero target using manual controls in "G" pattern. "Fire" (check "G" pattern with range finder)        |
| (24) _____  | _____        | 15. Tells Loader to load.  |
| (25) _____  | _____        | 16. Relays aiming cross on center of target with manual controls in "G" pattern. "Fire"  |
| (26) _____  | _____        | 17. Tells Loader to load.  |
| (27) _____  | _____        | 18. Relays aiming cross on center of target with manual controls in "G" pattern. "Fire" (Tell Gunner shot group is in a corner of the target)          |
| (28) _____  | _____        | 19. Tells Loader to load.  |
| (29) _____  | _____        | 20. Relays aiming cross on center of zero target using "G" pattern and manual controls. (Does not fire)  |
| (30) _____  | _____        | 21. Rotates boresight knobs on M32 periscope until aiming cross is in the center of group shot.  |
| (31) _____  | _____        | 22. Relays to center of zero target using manual controls in "G" pattern. "Fire" (Check with rangefinder) "Zero confirmed"                             |
| (32) _____  | _____        | 23. Relays to upper left-hand corner of zero target using manual controls in "G" pattern. (Check with rangefinder)                                     |
| (33) _____  | _____        | 24. Unlocks telescope boresight levers.  |
| (34) _____  | _____        | 25. Rotates boresight knobs until 1,200-meter range line on appropriate reticle is centered on upper left-hand corner of target. (Check sight picture) |
| (35) _____  | _____        | 26. Locks levers.  |
| (36) _____  | _____        | 27. Reads established zero for telescope and periscope.  |



# APPENDIX B

ID Number \_\_\_\_ (1-3)

## CRITICAL SKILLS QUESTIONNAIRE

1. Name \_\_\_\_\_
2. Company/Platoon \_\_\_\_\_ (4-5)
3. Social Security Number \_\_\_\_\_ (6-14)
4. What is your grade? (15)
 

E1 _____ (1)	E2 _____ (2)	E3 _____ (3)
E4 _____ (4)	E5 _____ (5)	E6 _____ (6)
5. How long have you been in the Army? (15)
 

_____ (1) less than 1 year
_____ (2) 1 year to 1 year 11 months
_____ (3) 2 years to 2 years 11 months
_____ (4) 3 years to 5 years
_____ (5) more than 5 years
6. How long have you been a trainer? (17)
 

_____ (1) less than 1 year
_____ (2) 1 year to 1 year 11 months
_____ (3) 2 years to 2 years 11 months
_____ (4) 3 years to 5 years
_____ (5) more than 5 years
7. What is your duty position? (18)
 

_____ (1) gunner
_____ (2) loader
_____ (3) driver
_____ (4) TC
_____ (5) other
8. How long have you held your duty position? (19)
 

_____ (1) 0-3 months
_____ (2) 4-6 months
_____ (3) 7-11 months
_____ (4) 1-2 years
_____ (5) more than 2 years
9. Which entry-level training course did you attend? (20)
 

_____ (1) 19E OSUT
_____ (2) 19F OSUT
_____ (3) 11E OSUT
_____ (4) 11E AIT
_____ (5) 11D AIT
_____ (6) entry level in another MOS

10. What is your Military Occupational Specialty (MOS)? (21-25)
- \_\_\_\_\_
11. What date did you graduate from either AIT or OSUT? (26-28)
- \_\_\_\_\_ month \_\_\_\_\_ year
12. How many total hours of training have you received on sight reticles during the last six months? (29)
- \_\_\_\_ (1) none  
\_\_\_\_ (2) 1-3 hours  
\_\_\_\_ (3) 4-5 hours  
\_\_\_\_ (4) 6-10 hours  
\_\_\_\_ (5) more than 10 hours
13. How recent was your last training on sight reticles? (30)
- \_\_\_\_ (1) never had training  
\_\_\_\_ (2) last week  
\_\_\_\_ (3) this month  
\_\_\_\_ (4) within 3 months  
\_\_\_\_ (5) more than 3 months ago
14. Can you make the appropriate initial lay on the target? (31)
- \_\_\_\_ (1) I cannot  
\_\_\_\_ (2) I can for some engagements  
\_\_\_\_ (3) I can for most engagements  
\_\_\_\_ (4) I can for all engagements
15. Can you take the correct lead for moving targets? (32)
- \_\_\_\_ (1) I cannot  
\_\_\_\_ (2) I can for some engagements  
\_\_\_\_ (3) I can for most engagements  
\_\_\_\_ (4) I can for all engagements
16. Can you correctly apply burst-on-target (BOT)? (33)
- \_\_\_\_ (1) I cannot  
\_\_\_\_ (2) I can for some engagements  
\_\_\_\_ (3) I can for most engagements  
\_\_\_\_ (4) I can for all engagements
17. Can you correctly adjust fire from a subsequent fire command? (34)
- \_\_\_\_ (1) I cannot  
\_\_\_\_ (2) I can for some engagements  
\_\_\_\_ (3) I can for most engagements  
\_\_\_\_ (4) I can for all engagements

18. Can you make the standard adjustment when an initial shot is lost? (35)
- ☐ (1) I cannot
  - ☐ (2) I can for some engagements
  - ☐ (3) I can for most engagements
  - ☐ (4) I can for all engagements
19. During training periods, how often does your crew boresight the main gun? (36)
- ☐ (1) daily
  - ☐ (2) weekly
  - ☐ (3) 1-2 times a month
  - ☐ (4) less than once a month
  - ☐ (5) never
20. During training periods, how often does your crew zero the main gun? (37)
- ☐ (1) daily
  - ☐ (2) weekly
  - ☐ (3) twice a month
  - ☐ (4) less than once a month
  - ☐ (5) never
21. When you last boresighted and zeroed the main gun, what procedure did you follow? (38)
- ☐ (1) gunner's instructions
  - ☐ (2) tank commander's instructions
  - ☐ (3) procedure in the Technical Manual (TM)
  - ☐ (4) other written instructions
  - ☐ (5) platoon leader's instructions
  - ☐ (6) platoon sergeant's instructions
  - ☐ (7) I don't remember or I have never boresighted and zeroed
22. Have you trained on boresighting and zeroing during your unit's SOT training? (39)
- ☐ (1) yes
  - ☐ (2) no
23. If you answered yes to Question 22, how long ago did you last train on boresighting and zeroing? (40)
- ☐ (1) within the last month
  - ☐ (2) 1-3 months ago
  - ☐ (3) 4-6 months ago
  - ☐ (4) 7 months to 1 year ago
  - ☐ (5) more than 1 year ago

24. If asked to boresight and zero the main gun of an M60A1 tank, could you do it correctly without help? (41)

- ☐ (1) very sure I can
- ☐ (2) fairly sure I can
- ☐ (3) fairly sure I can't
- ☐ (4) very sure I can't

25. When was your last Table 8? (42-44)

\_\_\_\_\_ month \_\_\_\_\_ year

26. What was your crew position during your last Table 8? (45)

- ☐ (1) tank commander
- ☐ (2) gunner
- ☐ (3) driver
- ☐ (4) loader
- ☐ (5) no previous Table 8

27. How did your crew do in its last Table 8? (46)

- ☐ (1) distinguished
- ☐ (2) qualified
- ☐ (3) non-qualified
- ☐ (4) no previous Table 8

28. What position do you expect to hold during the next Table 8 your crew participates in? (47)

- ☐ (1) tank commander
- ☐ (2) gunner
- ☐ (3) driver
- ☐ (4) loader